Introduction:

A Liquid Crystal Display commonly abbreviated as LCD is basically a display unit built using Liquid Crystal technology. It is an inevitable part in almost all embedded projects and this article is about interfacing a 16×2 LCD with 8051 microcontroller. Many guys find it hard to interface LCD module with the 8051 but the fact is that if you learn it properly, its a very easy job and by knowing it you can easily design embedded projects like digital voltmeter / ammeter, digital clock, home automation displays, status indicator display, digital code locks, digital speedometer/ odometer, display for music players etc etc.

Thoroughly going this article will make you able to display any text (including the extended characters) on any part of the 16×2 display screen. In order to understand the interfacing first you have to know about the LCD modules.

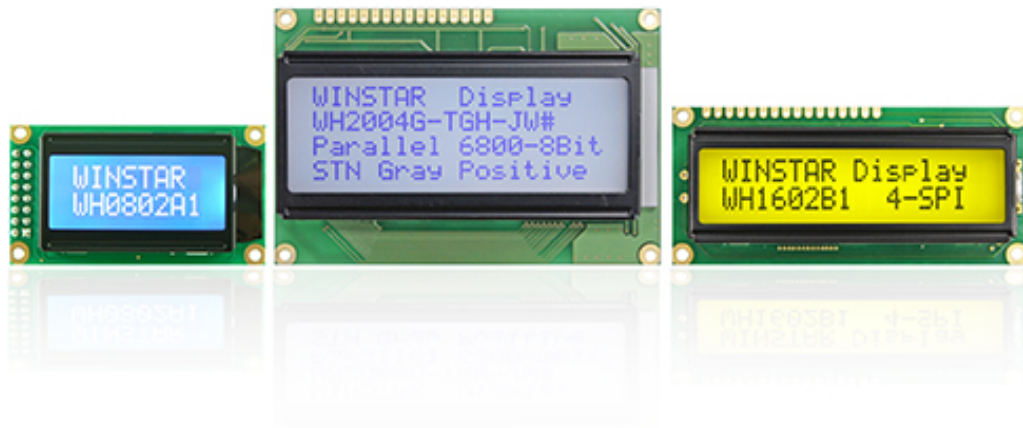## Hardware Discussion: Liquid Crystal Display (LCD)

Fig: Some of available LCD modules

LCD Features :

- Alphanumeric LCD display module, meaning can display alphabets and numbers.
- 16x2 LCD consists of two rows and each row can print 16 characters.
- Each character is build by a 5×8 pixel box.
- Can work on both 8-bit and 4-bit mode.
- It can also display any custom generated characters
- Available in Green and Blue Back light.
- Combinations available like, 8x1, 8x2, 16x1, 16x2, 16x4, 20x4 etc.
- Operating Voltage is 4.7V to 5.3V.
- Current consumption is 1mA without back light.

LCD Basics :

16×2 LCD module is a very common type of LCD module that is used in this tutorial. The pin numbers, their name and corresponding functions are shown in the table below.
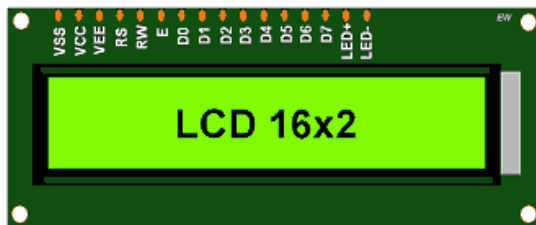
No.	PIN	Function
1	VSS	Ground
2	VCC	+5 Volt
3	VEE	Contrast control 0 Volt: High contrast.

No.	PIN	Function
4	RS	Register Select 0: Commannd Reg. 1: Data Reg.
5	RW	Read / write 0: Write 1: Read
6	E	Enable H-L pulse
7-14	D0 - D7	Data Pins D7: Busy Flag Pin
15	LED+	+5 Volt
16	LED-	Ground

Fig: LCD Pinout with description

How it works?

Now, we know that each character has (5×8=40) 40 Pixels and for 32 Characters we will have (32×40) 1280 Pixels. Further, the LCD should also be instructed about the Position of the Pixels. Hence it will be a hectic task to handle everything with the help of MCU, hence an Interface IC like HD44780 is used, which is mounted on the backside of the LCD Module itself. The function of this IC is to get the Commands and Data from the MCU and process them to display meaningful information onto our LCD Screen.

A 16×2 LCD has two registers like data register and command register. TheRS(register select) is mainly used to change from one register to another. Whenthe register set is '0', then it is known ascommand register. Similarly, when theregister set is '1', then it is known as data register.

The main function of the command register is to store the instructions of command which are given to the display. So that predefined tasks can be performed such as clearing the display, initializing, set the cursor place, and display control.

The main function of the data register is to store the information which is tobe exhibited on the LCD screen. Here, the ASCII value of the character is theinformation. Whenever we send the information to LCD, it transmits to the dataregister, and then the process will be starting there.

Now we can start for the test of a LCD. To do that we need to code for thecommon steps:

Programming LCD to Microcontroller :

Coming to the programming you should follow these steps:

- **STEP1**: Initialization of LCD
- **STEP2**: Sending command to LCD.

- **STEP3**: Writing the data to LCD.

LCD initialization :

To initialize LCD to the 8051 the following instruction and commands are to beembed in to the functions

- Send **38H** to the 8 bit data line for initialization
- Send **0FH** for making LCD ON, cursor ON and cursor blinking ON.
- Send **06H** for increment cursor position.
- Send **01H** for clearing the display and return the cursor.

Sending data to the LCD :

The steps for sending data to the LCD module is given below. I have already said that the LCD module has pins namely RS, R/W and E. It is the logic state of these pins that make the module to determine whether a given data input is a command or data to be displayed.

- Make R/W low.
- Make RS=0 if data byte is a command and make RS=1 if the data byte is adata to be displayed.
- Place data byte on the data register.
- Pulse E from high to low.
- Repeat above steps for sending another data.
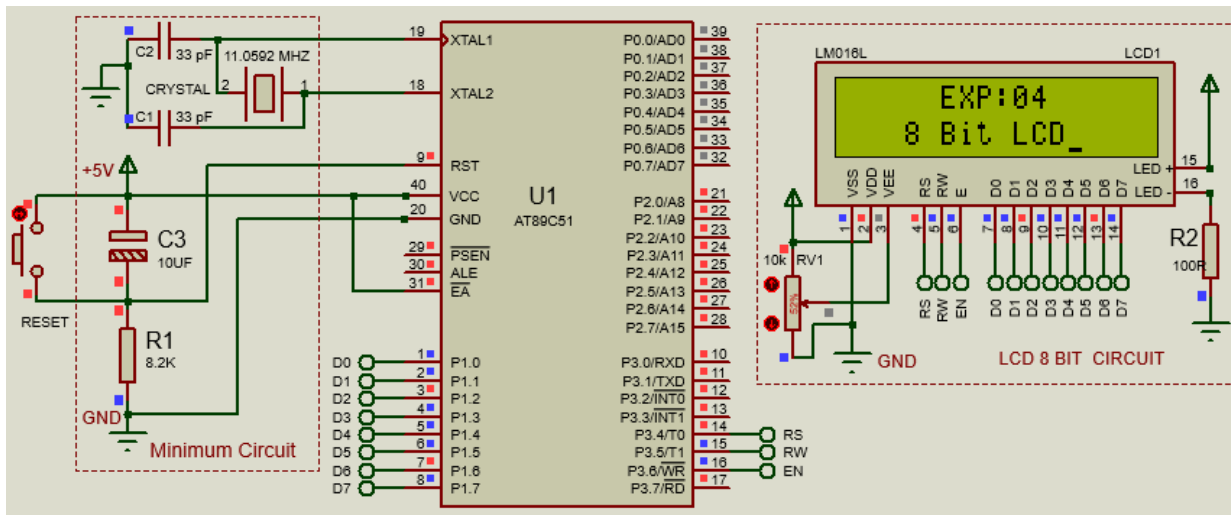
Circuit Diagram : 8 bit LCD Interfacing to 8051.

Fig: A Single Digit Seven Segment Display Circuit.

Circuit Discussion :

The circuit diagram given above shows how to interface a 16×2 LCD module with AT89S1 microcontroller. Capacitor C3, resistor R3 and push button switchS1 forms the reset circuitry. Ceramic capacitors C1,C2 and crystal X1 is related tothe clock circuitry which produces the system clock frequency. P1.0 to P1.7 pins ofthe microcontroller is connected to the DB0 to DB7 pins of the module respectively and through this route the data goes to the LCD module. P3.3, P3.4 and P3.5 are connected to the E, R/W, RS pins of the microcontroller and through this route the control signals are transferred to the LCD module. Resistor R1 limits the current through the back light LED and so do the back light intensity. POT R2 is used for adjusting the contrast of the display.